

Patent claims

1. A redundant cooling device for an electric submarine drive motor (1), with a first cooling circuit (2) and a second cooling circuit (3), by means of which thermal energy can be transported away from the electric submarine drive motor (1), characterized in that the coolant of the first cooling circuit (2) and the coolant of the second cooling circuit (3) flow in counter-current through a stator cooling ring (4) of the electric submarine drive motor (1) in the region of the electric submarine drive motor.
2. The redundant cooling device as claimed in claim 1, in which a main pump (5) and a minor pump (6) with considerably lower power in comparison with the main pump (5) are arranged in each cooling circuit (2, 3).
3. The redundant cooling device as claimed in claim 2, in which the main pump (5) and the minor pump (6) of each cooling circuit (2, 3) have supply voltages that are independent from each other.
4. The redundant cooling device as claimed in claim 2 or 3, in which each cooling circuit (2, 3) can be operated in a low speed range of the electric submarine drive motor (1) exclusively by means of the minor pump (6) assigned to it.
5. The redundant cooling device as claimed in claim 4, in which each cooling circuit (2, 3) can be operated above the low speed range of the electric submarine drive motor (1) by means of the main pump (5) assigned to it.

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6. The redundant cooling device as claimed in one of claims 1 to 5, between the two redundant cooling circuits (2, 3) of which transfer lines (10, 11) in which a coupling valve (12, 13) is respectively arranged are provided.
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7. The redundant cooling device as claimed in claim 6, in which the coolant circulation of the two cooling circuits (2, 3) connected to each other when the coupling valves (12, 13) are open can be accomplished by means of one of the two main pumps (5), the output power of the electric submarine drive motor (1) being adaptable to the amount of heat which can then be removed.
8. The redundant cooling device as claimed in one of claims 1 to 7, the redundant pump units, heat exchangers, fittings, valves, etc. of which are arranged on the upper part of the electric submarine drive motor (1).
9. The redundant cooling device as claimed in one of claims 1 to 8, the two cooling circuits (2, 3) of which each have a cooling branch (14), by means of which inverter modules (15) assigned to the submarine drive motor (1) can be cooled.
10. The redundant cooling device as claimed in one of claims 1 to 9, in which the coolant in the two cooling circuits (2, 3) can be re-cooled by means of sea water in a water-water heat exchanger (17) or water-air heat exchanger in each case.
11. The redundant cooling device as claimed in one of claims 2 to 10, in which the main pump (5) and the minor pump (6) of each cooling circuit (2, 3) is assigned a power supplying and a switching unit (9), the dedicated cooling plates of which can be cooled by means of a further cooling branch (18) of each cooling circuit (2, 3).
12. The redundant cooling device as claimed in one of claims 2 to 12, in which the motors (7) of the two minor pumps (6) of each cooling circuit (2, 3) are

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operated with a fixed supply voltage and/or supply frequency.

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13. The redundant cooling device as claimed in one of claims 2 to 12, in which the main pumps (5) of each cooling circuit (2, 3) are supplied via inverters, in order to adapt the delivery rate of the cooling liquid, and with it the amount of heat to be removed, via the variable speed of the motors (8).
14. The redundant cooling device as claimed in one of claims 2 to 13, in which the motors (8) of the two main pumps (5) are formed as squirrel-cage three-phase asynchronous motors.
15. The redundant cooling device as claimed in one of claims 2 to 14, in which an independent supply voltage is provided for each main pump (5) and minor pump (6).
16. The redundant cooling device as claimed in one of claims 1 to 15, in which each cooling circuit (2, 3) has an expansion vessel (21) for the cooling liquid.
17. The redundant cooling device as claimed in one of claims 1 to 16, in which each cooling circuit (2, 3) has a degassing device (27) and a service connection (22) for the cooling liquid.
18. The redundant cooling device as claimed in one of claims 1 to 17, in which each cooling circuit (2, 3) has a pressure-relief valve.
19. The redundant cooling device as claimed in one of claims 1 to 18, in which a temperature sensor (23) is arranged in each of the two cooling circuits (2, 3).
20. The redundant cooling device as claimed in one of claims 11 to 19, in which a pressure-independent

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flow governor (20, 16, 19) is respectively arranged in each of the two cooling circuits (2, 3) upstream of the stator cooling ring (4), upstream of the inverter

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modules (15) and upstream of the power supplying and switching unit (9).

- 5 21. The redundant cooling device as claimed in one of claims 1 to 20, in which a temperature-controlled three-way valve (25) is present in each of the two cooling circuits (2, 3).
- 10 22. The redundant cooling device as claimed in one of claims 2 to 21, in which a nonreturn valve is respectively present in a pressure side of the minor pumps (6) and the main pumps (5).
- 15 23. The redundant cooling device as claimed in one of claims 1 to 22, in which quick-action couplings (26) that shut off in both directions are arranged in the connecting elements between the redundant cooling device and the submarine drive motor (1).